Ministry of
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DOUBLE SURFACE TREATMENT WITHOUT PRIME VERSUS PRIME AND SINGLE SURFACE TREATMENT

Interim Report

MATERIALS INFORMATION
ENGINEERING MATERIALS OFFICE

DOUBLE SURFACE TREATMENT

WITHOUT PRIME

versus

PRIME AND SINGLE

SURFACE TREATMENT

INTERIM REPORT

by

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1.0 INTRODUCTION

Standard Ministry practice when surface treatment is used as a bituminous surface is to first prime the granular base with a liquid asphalt primer or an emulsified asphalt primer. Four to five days later when the primer has cured, a single surface treatment is placed over the prime using high float emulsion and 16.0 mm granular materials as a wearing course.

In Cochrane District the price of primer increased 49% over 1982 prices and in New Liskeard, Sault Ste. Marie and Thunder Bay Districts primer increased an average of 44% over 1982 prices and 1984 prices are expected to be even higher.

Actual 1983 tender prices show that there could have been an average savings of 14.1% in Kingston, New Liskeard, Cochrane, Thunder Bay and Kenora Districts by constructing double surface treatments (D.S.T.) in place of prime and single surface treatments (P & SST). It was therefore decided to construct some test sections of double surface treatment. Seven test sections using the same materials, high float emulsion and 16.0 mm granular, were placed directly over the granular base without prime.

The purpose of this report is to summarize information which may be used to determine the proper granular base conditions, the correct methods for construction and the long term performance characteristics of D.S.T. This report contains the granular base conditions encountered, the construction methods used, the short term performance and the costs of the D.S.T. test sections. The interim conclusions and recommendations based on these sections can be found on pages 11 and 12.

2.0 ANTICIPATED BENEFITS

The benefits expected by constructing double surface treatment without prime in place of prime and single surface treatment are:

1. Cost saving of up to 19% depending on job location.

2. Equivalent or better performance to prime and single surface treatment.

3. Savings in construction time as fewer moves are required.

4. Elimination of the loss of fresh primer due to sudden rain fall.

5. Elimination of the chance of damage to the granular base that exists during the curing period when primer is used.

6. Energy savings as some primers contain up to 50% solvent.

3.0 FACTORS TO BE DETERMINED

Before the Ministry can confidently construct double surface treatments without priming and recommend their use, several factors must be established and proven. For example:

1. What are the proper granular base conditions prior to construction such as type of granular base, degree of compaction, depth of float, calcium chloride, and dampness?

2. What are the correct construction procedures, such as application rates, rolling procedures, sweeping methods and length of time between applications?

3. Will there be any loose aggregate between the two surface treatments which may result in the loss of a portion of the second application?

4. Will the long term performance be equivalent to a prime and single surface treatment?

5. Will there be long term cost benefits?

4.0 CONSTRUCTION

Five of the test sections were on MTC highways and the remaining two in the Municipalities of the Town of Caledon and the County of Peterborough. Table 1 in the Appendix provides a summary of the construction data.

Hwy. 65

District: New Liskeard
Location: Approaches to Montreal and Sidney Creek bridges.
Length: 2.0 km
Contract No.: 83-517
Contractor: Seeley and Arnill
Date: 83 08 06
Surface Treatment Aggregate Source: MTC Pit 3F-28, Cont. 83-211
P & SST Cost: $10,344 per km.
D.S.T. Cost: $8,319 per km.

The granular base (from a gravel source) was damp, well compacted with approximately 2 cm of loose float on the surface prior to surface treating. Calcium chloride was not used.

Seeley and Arnill sprayed the HF-150S emulsion directly on the granular base at 1.37 kg/m^2 and spread class 2 aggregate immediately at 18.7 kg/m^2. Rolling with one rubber-tired and one steel-tired roller followed the aggregate application. The first application was not swept.

The second application of HF-150S emulsion and aggregate was placed in the same day at the same rates. Rolling was carried out with the two rollers.

A P & SST was not nearby for comparison.

Hwy. 96

District: Kingston
Location: 6 km east of Dawson Point Road, easterly
Length: 3.5 km
Contract No.: 40-83-05
Contractor: Harnden and King
Date: 83 08 09
Surface Treatment Aggregate Source: MTC Stockpile
P & SST Cost: N/A
D.S.T. Cost: $12,000 per km.

The granular base was constructed from quarried limestone, was damp and thoroughly compacted with approximately 1 cm of float at the time of surface treating. A light application of calcium chloride had been placed for compaction and dust control.

HF-150S emulsion was sprayed on the granular base at 1.50 kg/m^2 and Class 2 aggregate (also a quarried limestone) was applied at 17.6 kg/m^2. Rolling following immediately with one 8 t rubber-tired and one 9 t steel-tired roller. Approximately 1 km of the first application was completed in both lanes. The first application was not swept.

The second application of HF-150S emulsion and aggregate was placed in the same day at 1.44 kg/m^2 and 17.0 kg/m^2. Rolling with the two rollers followed.

When the second application over the first km was completed, the Contractor constructed the second km using the same materials, equipment and procedures followed by the final 1.5 km.

There was not a P & SST nearby for comparison.

Previous Work, Hwy. 95

Kingston District placed DST's without prime in 1980 and 1982. Hwy. 95 (3.2 km), placed in 1980, is currently in very good condition with only slight bleeding visible. At the time of surface treating, the limestone granular base was well compacted, with a light application of calcium chloride and some loose float present. HF-150S was sprayed at 1.80 kg/m^2 followed by class 2 aggregate at 20.0 kg/m^2. The first application was rolled. The first application was not swept, however, there was a windrow of loose aggregate which was levelled with the rear wheels of the trucks the next day.

The second application of HF-150S emulsion was sprayed at 1.50 kg/m^2 followed by class 2 aggregate at 1.80 kg/m^2. The second application was rolled.

Previous Work, Hwy. 96

Hwy. 96 (3.2 km) constructed in 1982, is currently in good condition except for bleeding on the curves and hills caused by truck traffic.

The granular base at the time of surface treating was in similar condition to Hwy. 95. The construction procedures for the first and second applications were the same as on Hwy. 95, except for the application rates. The application rates for HF-150S emulsion and class 2 aggregate on the first application were: 1.84 kg/m^2 and 20.2 kg/m^2. The rates for the second application were 1.67 kg/m^2 and 18.2 kg/m^2.

Hwy. 596

District: Kenora
Location: 1.1 km north of the Kenora By-Pass from the HL4 northerly
Length: 3.0 km
Contract No.: 83-510
Contractor: Evans
Date: 83 08
Surface Treatment Aggregate Source: Olson Pit.
P & SST Cost: $13,195 per km.
D.S.T. Cost: $11,903 per km.

The granular base (from a gravel source) was damp, well compacted, with approximately 2 cm of loose float prior to surface treating. Calcium chloride had not been used this year.

Evans sprayed HF-150S emulsion at 1.56 kg/m^2 directly over the granular base followed by class 2 aggregate at 23.1 kg/m^2. Rolling was carried out with 2 rollers, one rubber-tired and one steel-tired. The first application was not swept.

In the same day, the second application was placed using the same rates and methods.

A P & SST comparison section, newly constructed, begins at the north end of the DST and continues northerly.

Hwy. 608

District: Thunder Bay
Location: From Jct. Hwy. #597 Westerly
Length: 0.3 km
Contract No.: 83-526
Contractor: Miller
Date: 83 08
Surface Treatment Aggregate Source: Strom's Pit.
P & SST Cost: $11,579 per km.
D.S.T. Cost: $10,000 per km.

The granular base (from a gravel source) had been scarified, graded and had received a heavy application of calcium chloride. At the time of surface treating, road was damp and hard packed from the calcium chloride with very little loose float.

HF-150S emulsion was sprayed directly on the granular base at 1.80 kg/m^2 followed by class 2 aggregate at approximately 18 kg/m^2. Rolling with one rubber-tired and one steel-tired single drum roller followed the aggregate application. The first application was not swept.

The second application, placed in the same day, was at 1.65 kg/m^2 of HF-150S emulsion and approximately 17 kg/m^2 for the class 2 aggregate. Compaction followed with the two rollers.

A section of P & SST was not nearby for comparison.

Hwy. 634

District: Cochrane
Location: South of Hydro Dam
Length: 0.20 km
Contract No.: N/A
Contractor: MTC
Date: 83 07 26
Surface Treatment Aggregate Source: Abitibi Canyon Stockpile
P & SST Cost: $8,650 per km.
D.S.T. Cost: $7,500 per km.

The granular base (from a granular source) was damp, well compacted with approximately 2 cm of loose float. Calcium chloride had not been applied to the granular base.

HF-150S emulsion was sprayed at 1.75 kg/m^2 followed immediately by 16 mm type "B" aggregate at 22.5 kg/m^2. The aggregate was rolled with one rubber-tired and two tandem steel-tired rollers. The first application was swept four days later.

The second application of emulsion and aggregate was also at 1.75kg/m^2 and 22.5 kg/m^2 respectively. Rolling was carried out in the same manner with the three rollers.

Newly constructed P & SST was adjoining the test section for comparison purposes.

2nd Line
Town of Caledon

Location: Township of Albion, from County Road 9 southerly
Length: 0.833 km
Contract No.: N/A
Contractor: T.J. Pounder
Date: 83 09 07
Surface Treatment Aggregate Source: Caledon Sand and Gravel
P & SST Cost: $10,926 per km.
D.S.T. Cost: $10,374 per km.

The granular base, reconstructed this summer, was from a granular source. The base was dry and dusty with about 2 cm of loose float on the surface. Calcium chloride had not been used.

HF-250S emulsion was sprayed in the northbound lane at 2.00 kg/m^2 and 22.4 mm granular was spread immediately at 28 kg/m^2. The aggregate in the north bound lane was not rolled or swept.

The second application, in the north bound lane, also at 2.00 kg/m^2 and 28 kg/m^2 was placed over the first application within 15 - 20 minutes. The second application was rolled with one 8 t rubber-tired and one single drum steel-tired roller.

The first application of HF-250S emulsion and 22.4 mm granular was placed in the southbound lane at 2.00 kg/m^2 and 28 kg/m^2. The south bound lane was rolled with the two rollers. The first application was not swept.

Within 15 - 20 minutes, the second application was placed in the south bound lane at the same rates as the first application. Rolling followed with the two rollers.

A P & SST, constructed at the same time, begins at the south end of the D.S.T. and continues southerly for several miles.

Road 38
County of Peterborough

Location: From Hwy. 7 southerly
Length: 3.5 km
Contract No.: N/A
Contractor: Royel Paving Ltd.
Date: 1983
Surface Treatment Aggregate Source: Pinewood Aggregates
P & SST Cost: N/A
Triple S.T. Cost: $15,000 per km.

The granular base (from a gravel source) was reconstructed in 1982 to County design standards. The granular base, at the time of surface treating, was damp and had received a moderate application of calcium chloride placed earlier in the year.

County Road 38 differed from the other test sections in that a triple surface treatment was placed. The first application was with HF-150S emulsion and class 2 aggregate and the second and third applications were with CRS-1 emulsion and class 1 aggregate.

First Application
HF-150S emulsion was sprayed on the granular base at 1.25 kg/m^2 followed by class 2 aggregate at 16.8 kg/m^2. Rolling was carried out with one rubber-tired roller. The first application was not swept.

Second and Third Applications

Five days after the first application the second application was placed using CRS-1 emulsion at 1.70 kg/m^2 and class 2 aggregate at 16.8 kg/m^2. Rolling was carried out with one steel-tired roller. The second application was not swept.

The third application was placed in the same day as the second application using the same materials, application rates and methods.

A P & SST, is not nearby for comparison.

5.0 OBSERVATIONS

5.1 Granular Base Condition

The granular base material was from gravel pits with the exception of Hwy. 96 which was from a limestone quarry. The granular base material on Hwy. 596 differed from the other granular base materials because it was cleaner (approximately 4% passing the 75 um sieve).

At the time of spraying, the granular bases were well compacted with calcium chloride used at 3 of the 7 sites. All the grades were damp except the 2nd Line of Albion. The depth of float ranged from 1 - 2 cm.

The AADT of the test sites ranged from 100 to 739.

5.2 Construction Procedures

Generally the construction methods used in the test sections were similar to those used in standard surface treatment work. The high float emulsion was sprayed directly over the granular base and the Class 2 aggregate was applied immediately. On Hwy. 596, the first application of HF-150S was absorbed into the granular base (possibly due to the clean granular base material) leaving insufficient emulsion to retain all the cover aggregate.

First Application

High float emulsion was sprayed directly on the granular bases followed immediately by graded aggregate. Rolling followed the aggregate application except for the north bound lane in the Town of Caledon. The first application was not swept in 6 out of 7 test sections. Hwy. 634 was swept between the first and second application.

Second Application

The second application was placed the same day in 5 of the 7 test sections. On Hwy. 634, the second application was placed 4 days later and on Peterborough Country Road 38, 5 days later. Rolling followed the application[2] of aggregate.

The second and third applications on Road 38 were placed the same day using CRS-1 emulsion and class 1 aggregate.

Application Rates

First Application

The HF-150S was sprayed at rates ranging from 1.25 to 2.00 kg/m^2. The average application[2] rate was 1.60 kg/m^2.

Class 2 aggregate was applied at rates ranging from 16.8 - 28.0 kg/m^2. The average application rate[1] was 19.5 kg/m^2.

Second Application

The HF-150S emulsion was sprayed at rates ranging from 1.37 to 2.00 kg/m^2. The average application rate[2] was 1.55 kg/m^2.

Class 2 aggregate was applied at rates from 16.8 to 28.0 kg/m^2. The average application[2] rate was 19.7 kg/m^2.

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1. 2nd Line of Caledon omitted.
2. 2nd Line and Road 38 omitted.

5.3 Performance

Currently 6 of the 7 test sections are in good or very good condition and are equal to the prime and single surface treatment control areas.

On the Hwy.596 test section, potholes are developing along centreline. It is not certain whether the potholes are a result of poor centreline joint construction or insufficient of emulsion. Also the D.S.T. on Hwy. 596 is rough for reasons not yet determined.

Any loss of the second application of surface treatment as a result of loose aggregate present between the first and second application has not been observed to date.

6.0 CONCLUSIONS

6.1 High Float Emulsion

High float emulsions are medium setting and permit wetting of the fines in the granular base and the cover aggregate. This results in better adhesion between the granular base and the surface treatment. The use of any other type of emulsion is not recommended.

6.2 Class 2 Aggregate

Graded aggregates meeting the requirements of class 2 aggregate are recommended for DST without prime.

6.3 Granular Base Condition

Hard packed granular bases with very little loose float seem to be the most suitable for D.S.T. Quarried limestone material is the best example. Clean granular base material such as used on Hwy. 596 tend to absorb the high float emulsion suggesting that a light application of calcium chloride or a slightly higher rate of emulsion on the first application should be used. The moderate use of calcium chloride on the granular bases does not appear to adversly affect the performance of D.S.T.

6.4 Construction Procedures

(a) The suggested application rates for future D.S.T. work are:

First Application

HF-150S	1.55 - 1.65 kg/m^2
Class 2 Aggregate	17.5 - 19.5 kg/m^2

Second Application

HF-150S	1.40 - 1.55 kg/m^2
Class 2 Aggregate	17.0 - 19.0 kg/m^2

(b) Each application of emulsion and aggregate should be rolled.

(c) Care should be taken to avoid spillage of aggregate on the first application of aggregate to prevent roughness.

(d) Additional care should be taken when constructing the centre-line joint.

(e) Sweeping, on longer sections, should be carried out 1 or 2 days after the first application.

6.5 Costs

There was an actual average material cost savings of 14.1% based on the contract prices from four Districts as a result of constructing D.S.T. in lieu of P&SST. A further savings is anticipated in D.S.T. construction costs because the contractor will have fewer moves.

7.0 RECOMMENDATIONS

1. The Districts should continue to monitor the performance of the tests over the winter with very careful monitoring during 1984.

2. The Districts should construct several similar test sections in 1984 using high float emulsion and class 2 aggregate. The test sections should be a minimum of 1 km in length and located near a P&SST for comparison purposes.

3. The Bituminous Section should produce a report on the performance of the 1983 work and on the construction of the 1984 work.

4. If the 1983 and 1984 work proves successful, consideration should be given to including double surface treatment without prime as part of the 1985 surface treatment contracts.

8.0 ACKNOWLEDGEMENTS

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TABLE 1: DOUBLE SURFACE TREATMENT TEST SITES & CONSTRUCTION DATA

LOCATION	DATE CONSTRUCTED	EMULSION GRADE	AGGREGATE TYPE	EMULSION RATE kg/m^2		AGGREGATE RATE kg/m^2		1st APPLICATION		2nd APPLICATION PLACED SAME DAY	NO. OF DAYS BETWEEN APPLICATIONS	P + SST NEARBY FOR COMPARISON	AADT 1980	GRANULAR BASE MATERIAL FROM	DEPTH OF LOOSE FLOAT ON GRANULAR BASE cm	NO. K-T ROLLERS	NO. S-T ROLLERS	$Ca\,cl_2$ USED ON GRADE	PERFORMANCE TO 83 09
				1st Appl	2nd Appl	1st Appl	2nd Appl	ROLLED	SWEPT										
Hwy. 65	83 08 06	HF-150S	Class 2	1.37	1.37	18.7	18.7	YES	NO	YES	0	NO	200	PIT	2[1]	1	1	NO	GOOD
Hwy. 96	83 08 09	HF-150S	Class 2	1.50	1.44	17.6	17.0	YES	NO	YES	0	NO	100	LIMESTONE QUARRY	0	1	1	YES	VERY GOOD
Hwy. 596	83 08	HF-150S	Class 2	1.56	1.56	23.1	23.1	YES	NO	YES	0	YES	550	PIT	2[1]	1	1	NO	FAIR
Hwy. 608	83 08	HF-150S	Class 2	1.80	1.65	18.0[1]	17[1]	YES	NO	YES	0	NO	250	PIT	1[1]	1	1[5]	YES	GOOD
Hwy. 634	83 07 26	HF-150S	Class 2	1.75	1.75	22.5	22.5	YES	YES	NO	4	YES	300	PIT	2[1]	1	2	NO	GOOD
2nd Line Town of Caledon	83 09 07	HF-250S	Gran. A[2]	2.00	2.00	28.0	28.0	NOTE[4]	NO	YES	0	YES	290	PIT	2	1	1[5]	NO	GOOD
Road 38 Peterborough County	1983	HF-150S & CRS-1[8]	Class 2 & Class 1[3]	1.25[7]	1.70[7]	16.8	20.0[6]	YES	NO	NO	5	NO	739	PIT	N/A	1	1	YES	VERY GOOD
			AVERAGE	=1.60[9]	1.55[9]	19.5[10]	19.7[9]												

1. Estimated
2. Granular "A" Passing 22.4 mm sieve.
3. Class 1, Washed Chips Passing 13.2 mm sieve.
4. S.B. Lane, Rolled on 1st Application,
   N.B. Lane Not Rolled on 1st Application.
5. Single Drum With Rubber Drive Wheels.
6. Based on 1 m^3 = 1.20 t.
7. Assumed Pavement Width of 6.71 m.
8. Double application of CRS-1 and Class 1 aggregate.
9. 2nd Line and Road 38 omitted.
10. 2nd Line omitted.

FIGURE 1: TYPICAL SURFACE TREATMENT AGGREGATE GRADATIONS